Microbes from Extreme Environments & an Astrobiology Course

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O_2 evolution is a universal signature of oxygenic photosynthesis. Detection of the presence, speed and efficiency of the enzymatic machinery that catalyzes this process *in vivo* is described using a home-built pulsed-laser Fast Repetition Rate Fluorometer (FRRF) (poster Ananyev et al.). The FRRF allows accurate and rapid measurements of these properties via the kinetics of Chlorophyll-*a* variable fluorescence yield (Fv) in whole cells at repetition rates up to 10 kHz. Two applications are described: 1) characterization of cyanobacteria and eukaryotes from extreme environments, including hot springs, alkaline soda lakes, dessicated spores and lichens, and 2) a student experiment created for an Astrobiology course at Princeton. Identification of O_2-evolving phototrophs was possible due to the stimulation of primary charge recombination within Photosystem (PSII) by the O_2-evolving complex (OEC) which causes Fv to cycle with a period of four flashes. The rate of PSII turnover is significantly faster and the misses in O_2 production (Kok α and β parameters) are fewer from carbonate-requiring cyanobacteria from soda lakes, with implications for the evolutionary origin of oxygenic photosynthesis. The kinetics of recovery of phototrophic metabolism upon transition from dormant spore to active phase in lichens will be illustrated, and $^{18}O/^{16}O$ and D/H isotope effects on the yield of OEC turnover. Students in Astrobiology255 used this spectrometer together with (optical) phase - contrast microscopy and chemical analysis to characterize photosynthetic function in biofilms

and planktonic cells sampled during a field trip to the LaDuke hot springs near Yellowstone. The experiment and student reception will be described.